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Tanner et al.

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(54) **IN OR RELATING TO BEVERAGE
PREPARATION MACHINES**

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(58) **Field of Classification Search**

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USPC **99/295, 279, 302 R, 289 R, 323; 49/248,**
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See application file for complete search history.

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Primary Examiner — Dana Ross

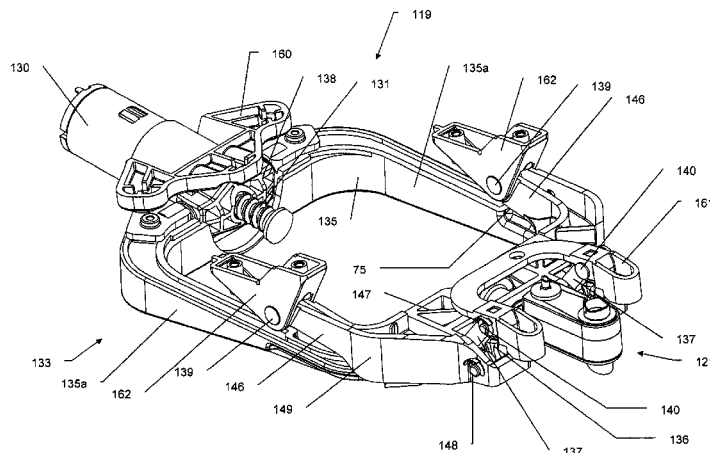
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(57) **ABSTRACT**

A delivery head for a beverage preparation machine including
a movable first part and a fixed second part, the first part being
movable relative to the second part between an open position
and a closed position, in the open position the first part being
positioned to enable loading of a cartridge into the delivery
head, in the closed position the first part and second part being
positioned to hold the cartridge in a dispensing position, the
delivery head further comprising an inlet piercer and an outlet
piercer, the inlet piercer and the outlet piercer being orien-
tated substantially in the same direction and being pivotable
relative to the fixed second part between a retracted position
and a piercing position.

30 Claims, 12 Drawing Sheets



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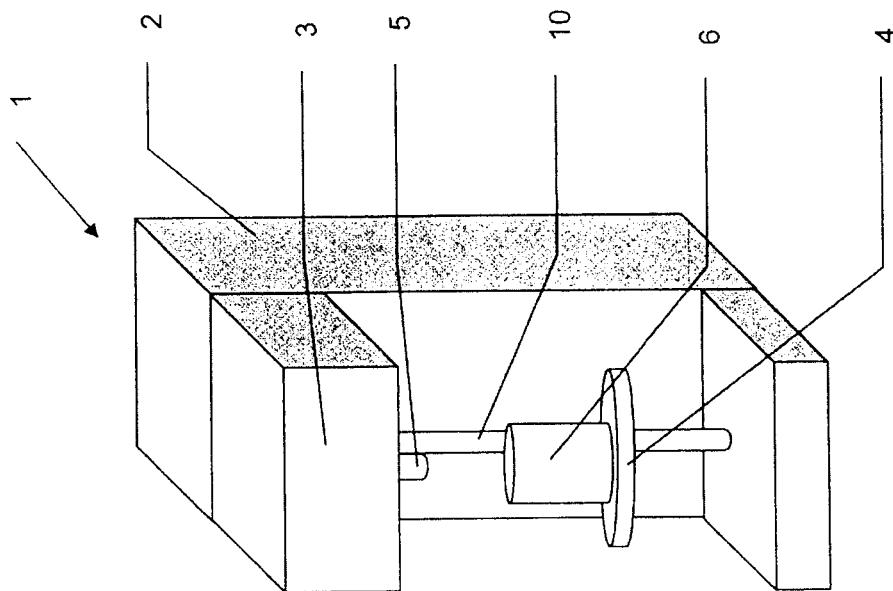


Fig. 2

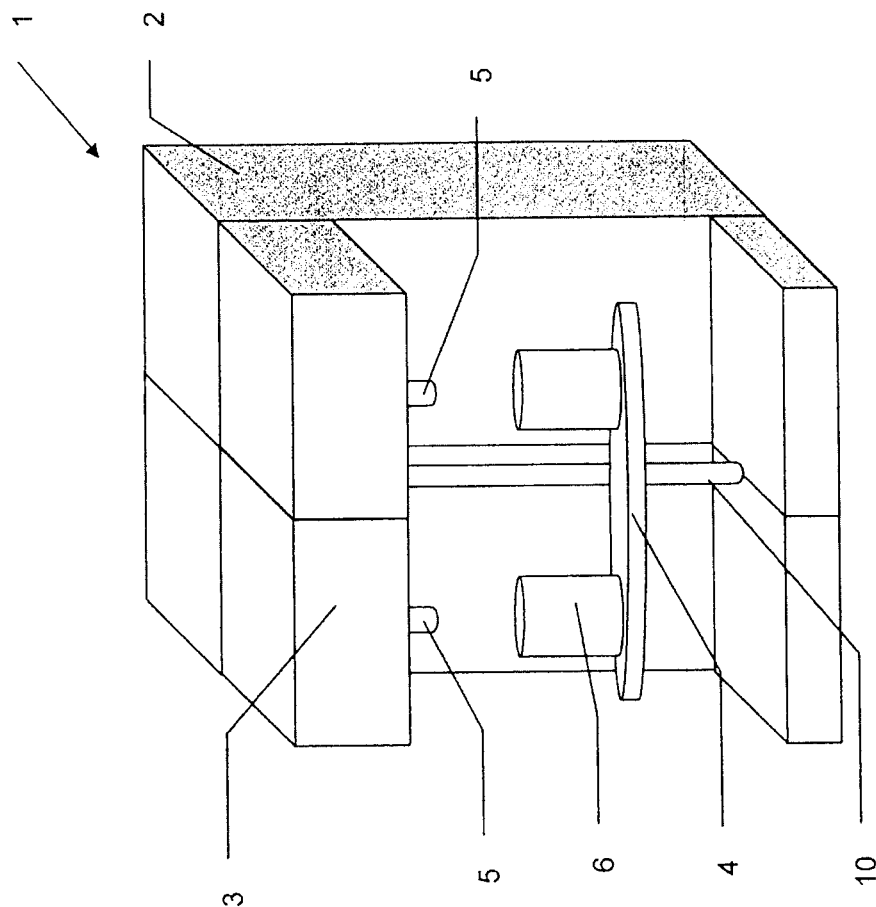


Fig. 1

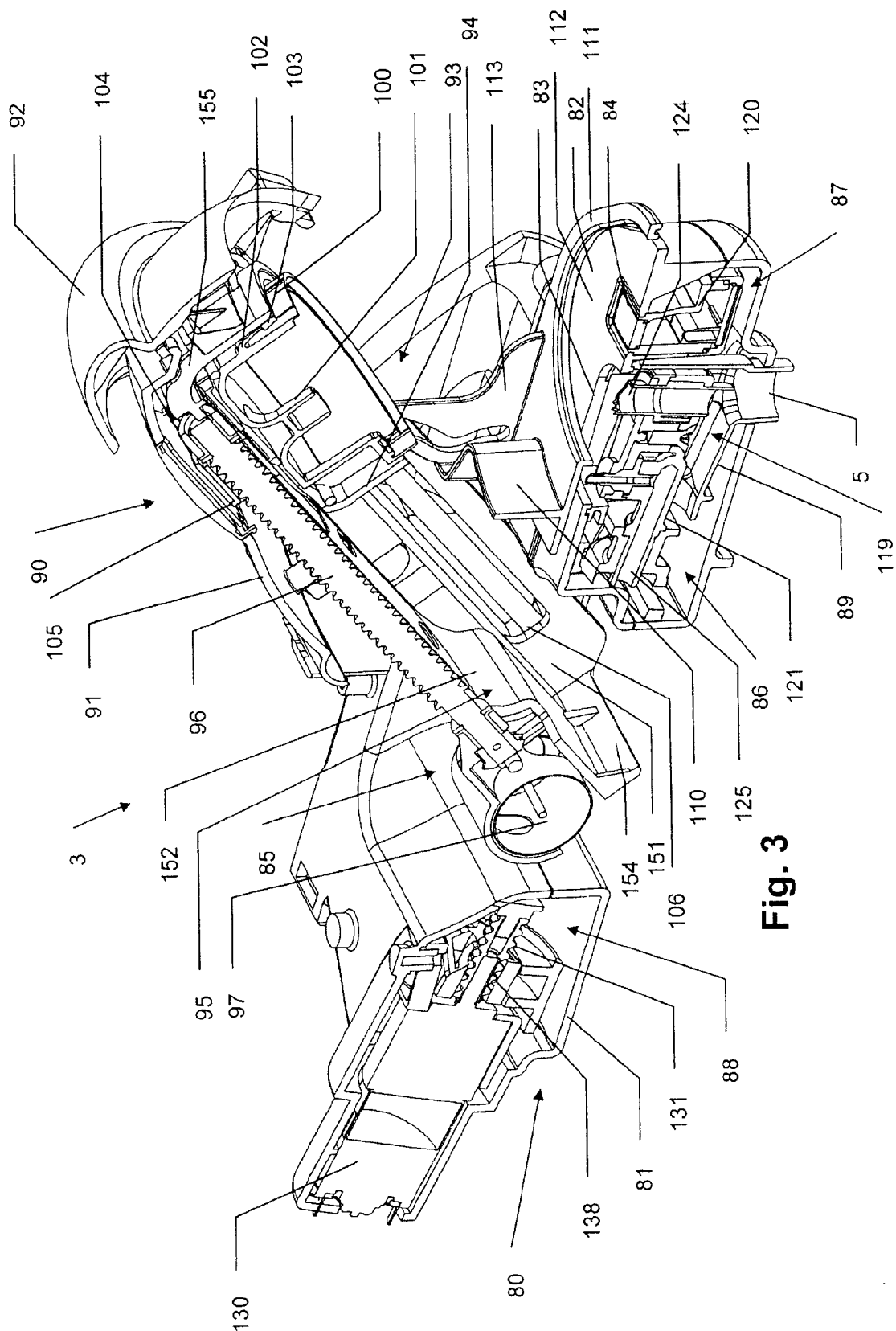


Fig. 3

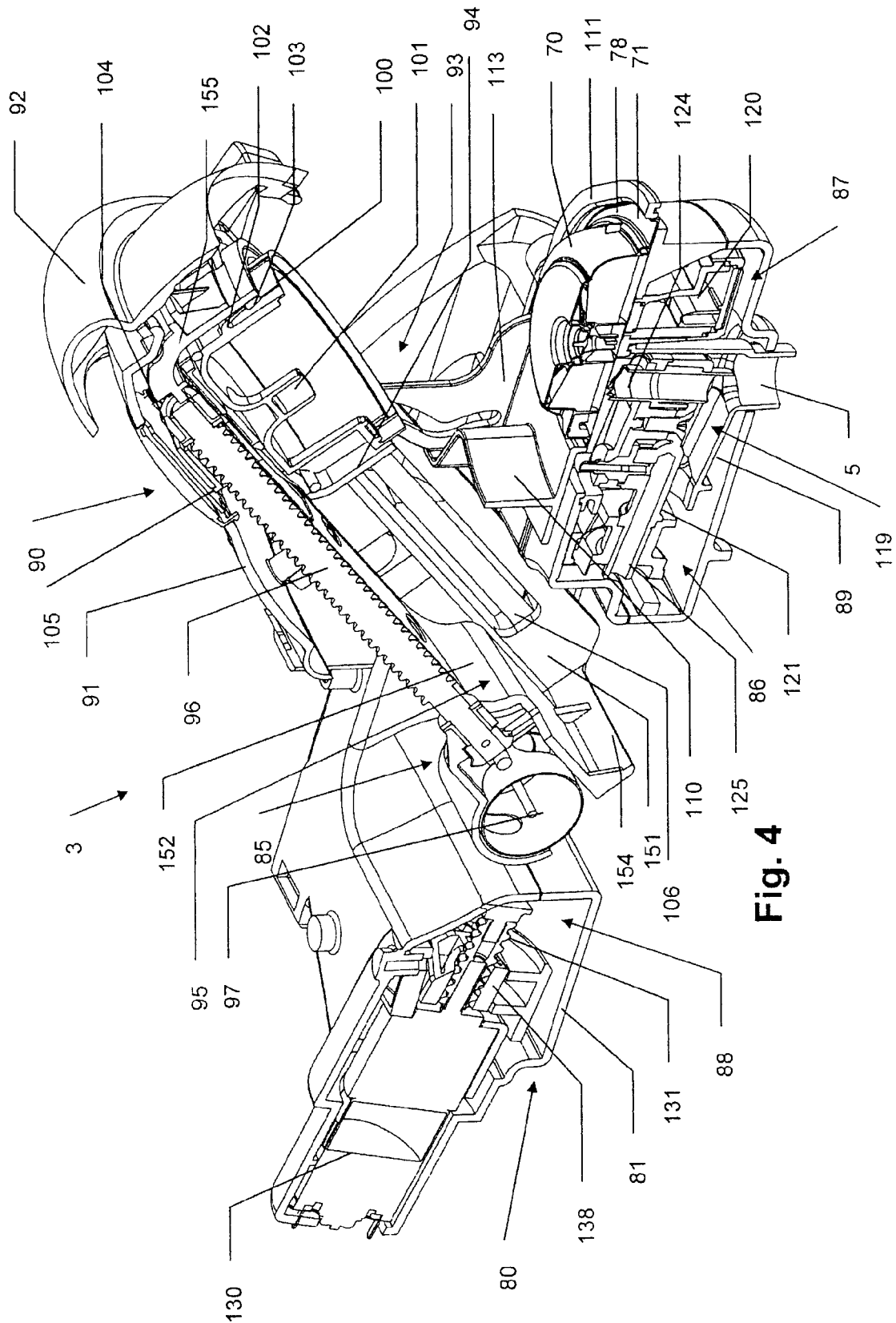
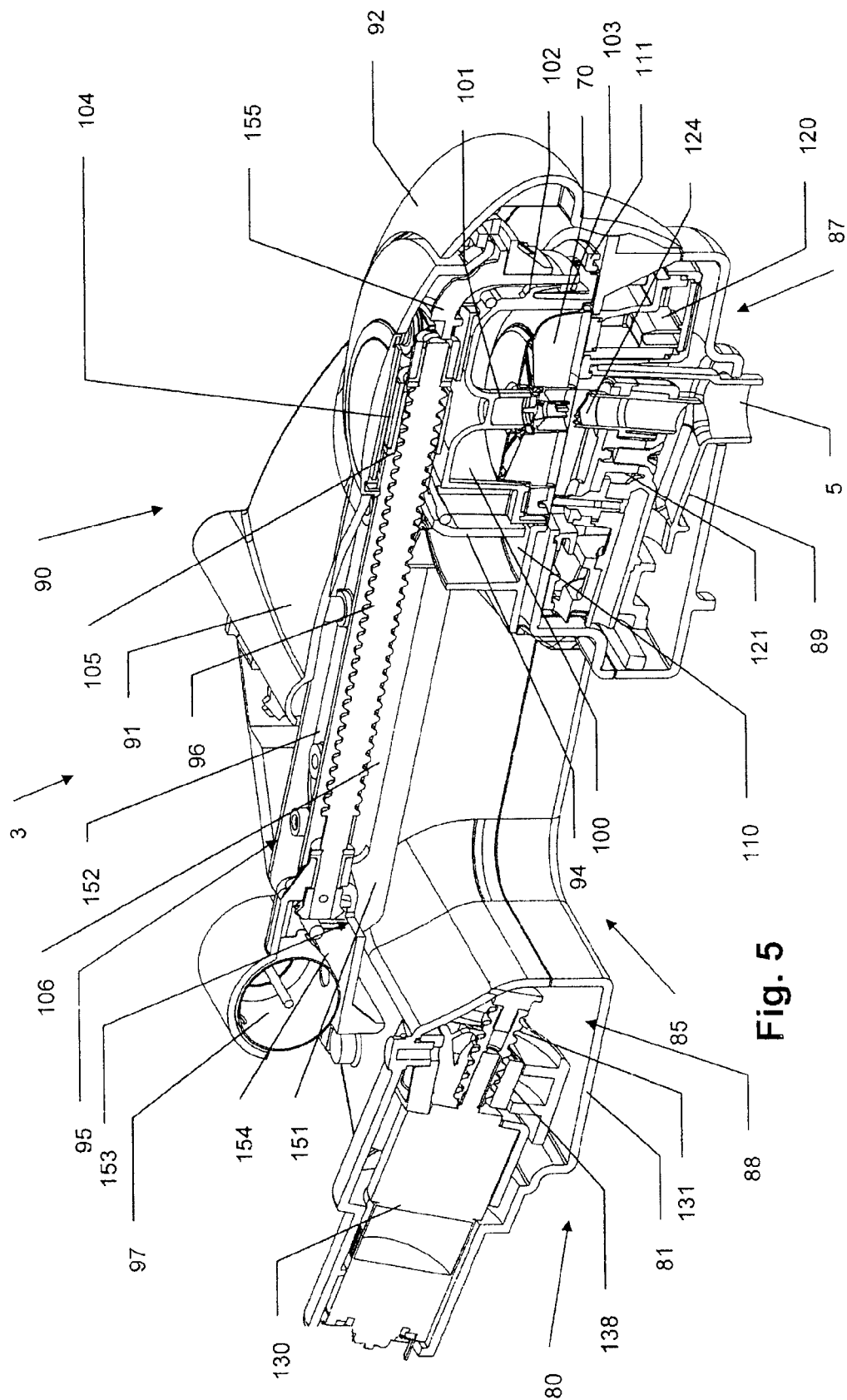


Fig. 4



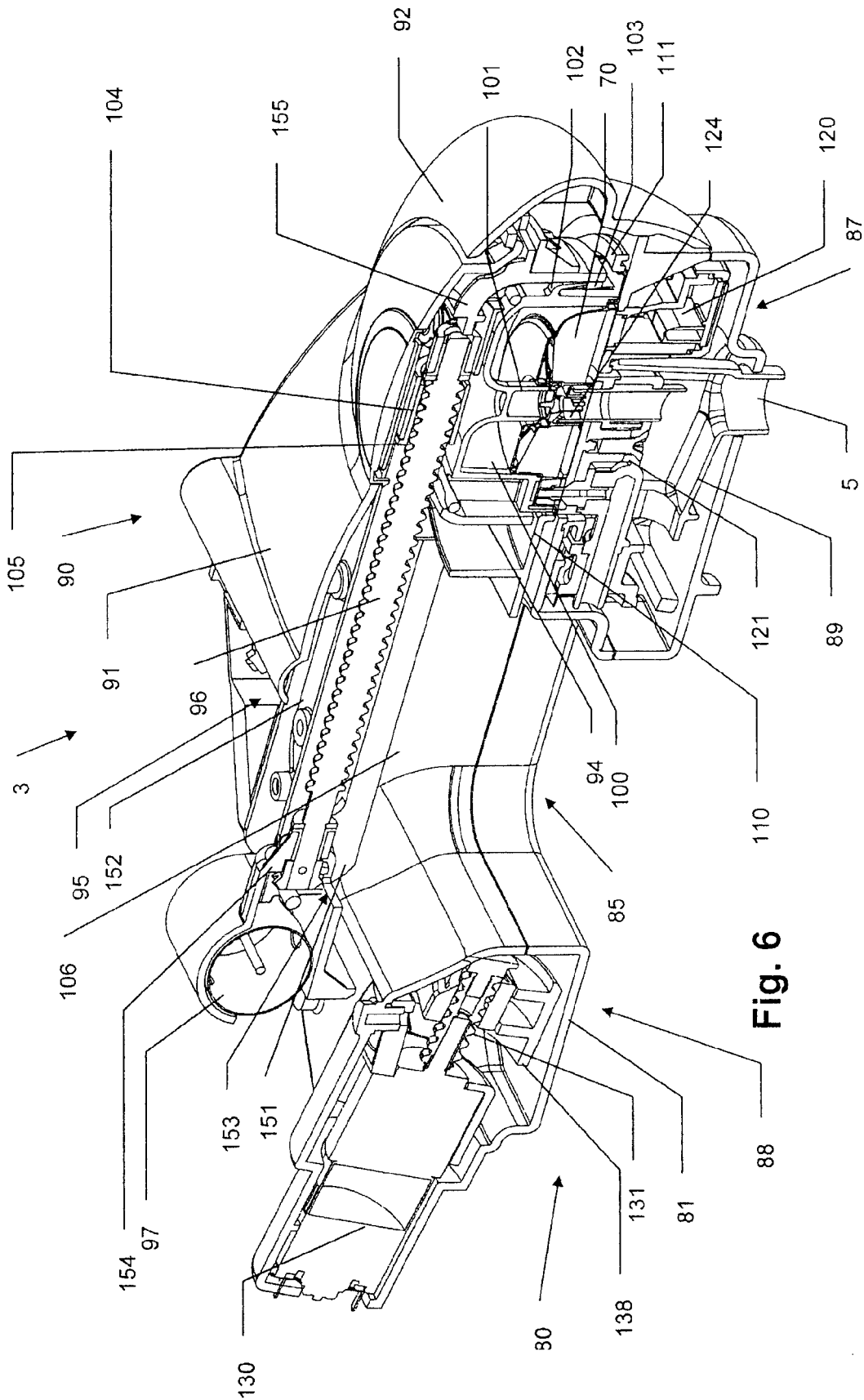
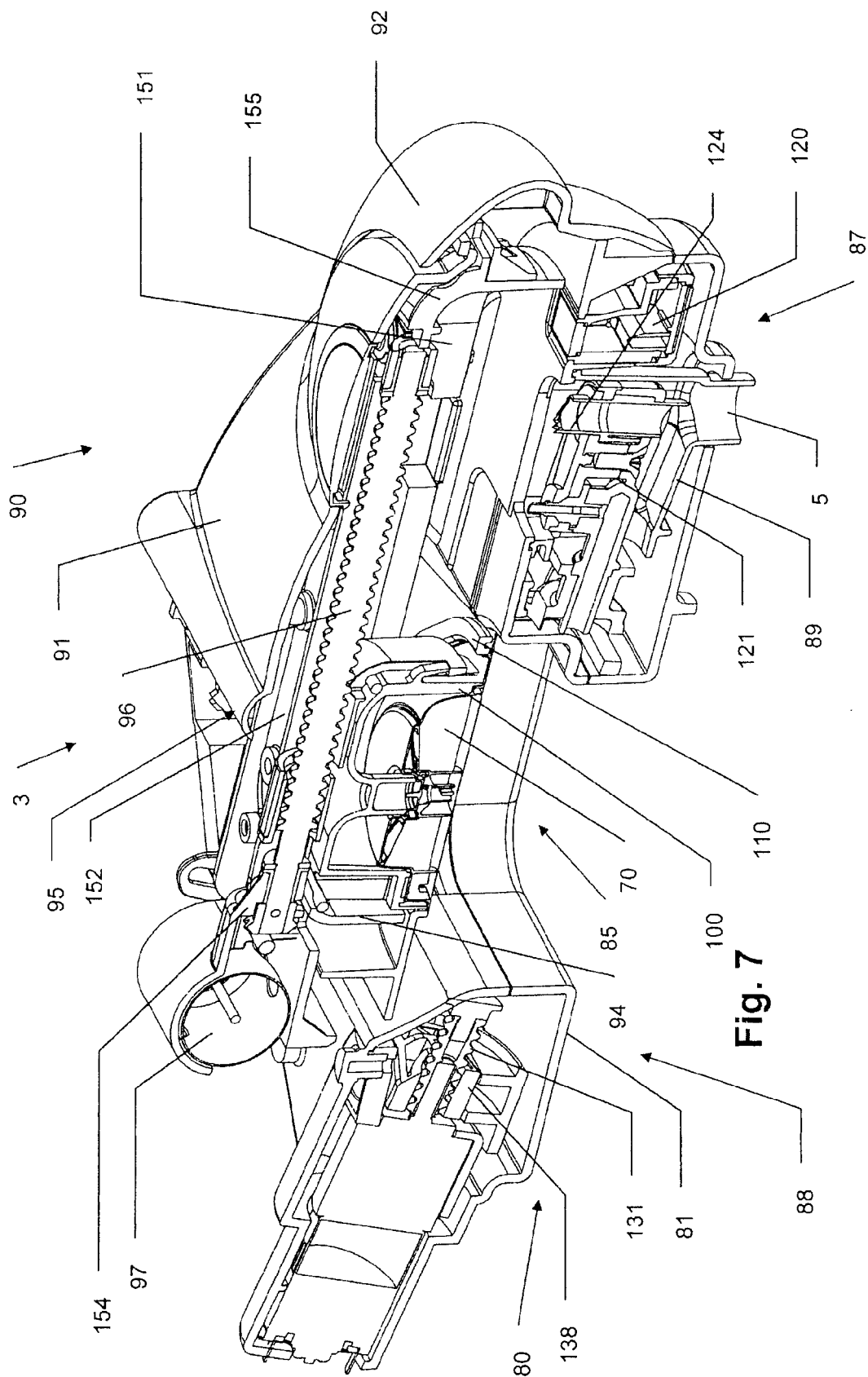


Fig. 6



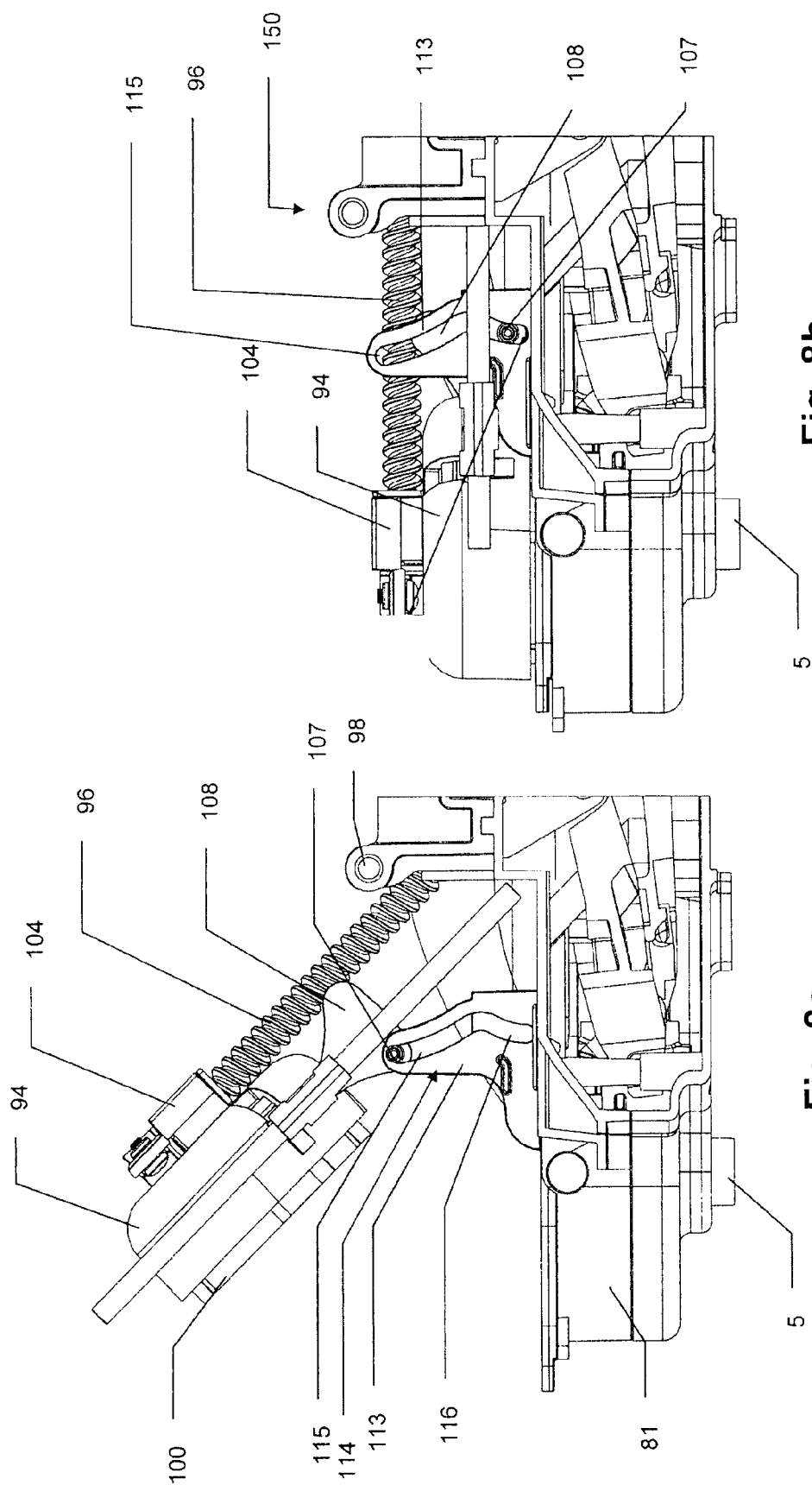
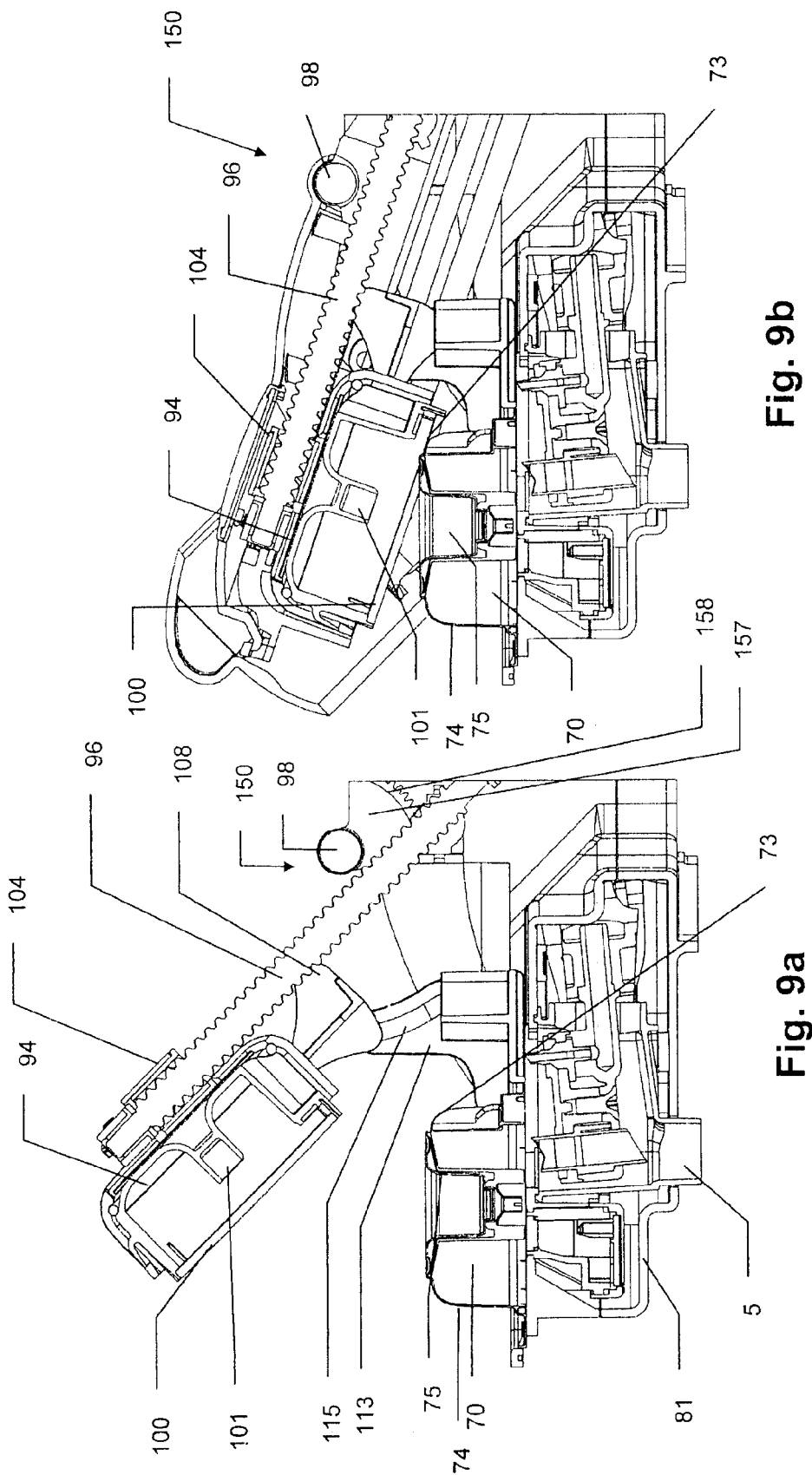


Fig. 8b

Fig. 8a



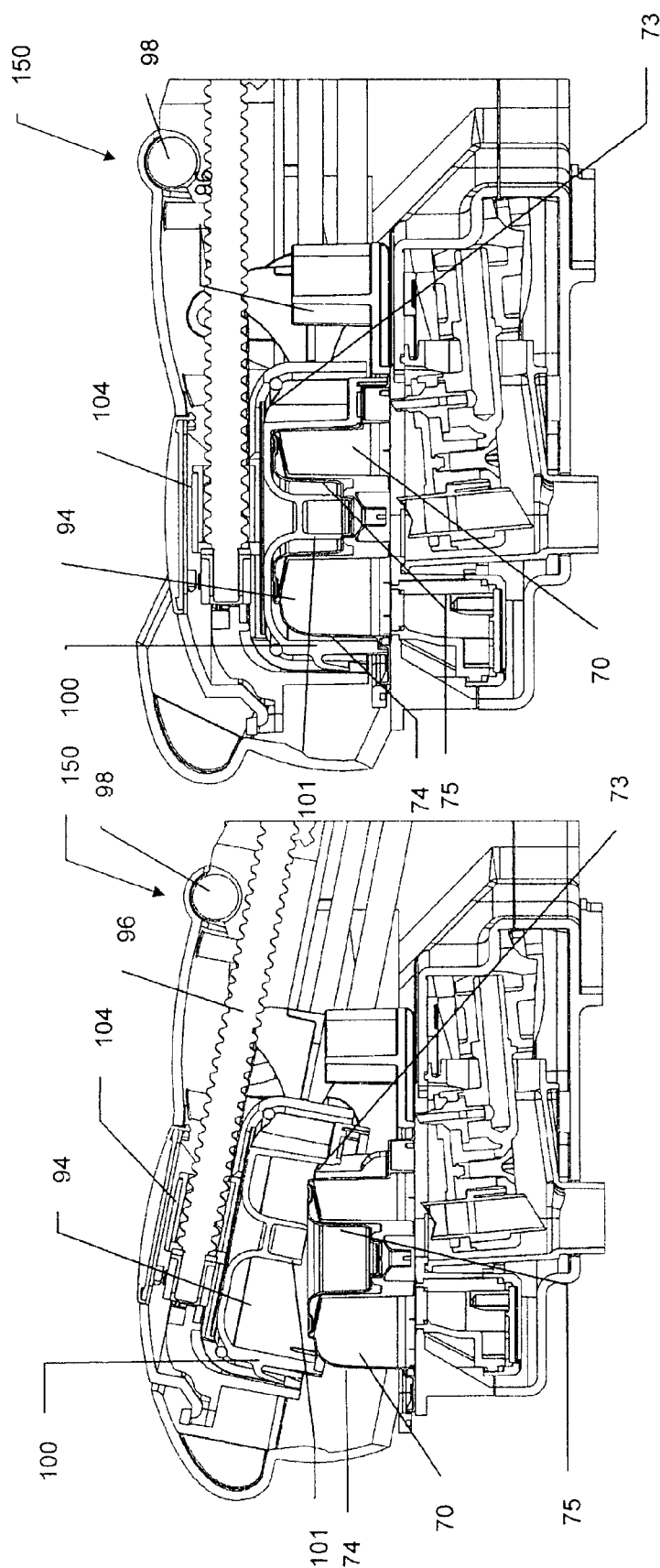
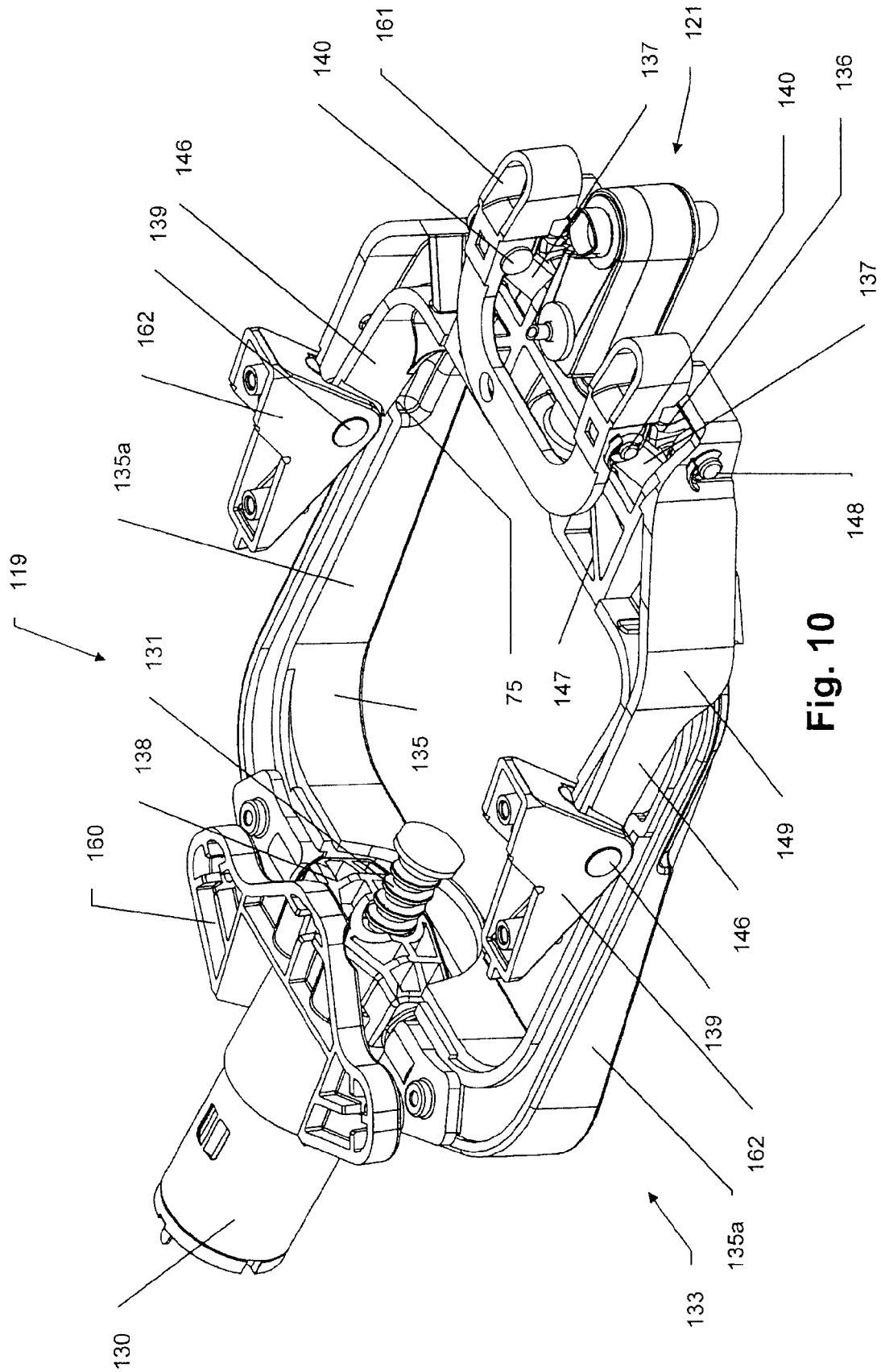


Fig. 9d

Fig. 9c



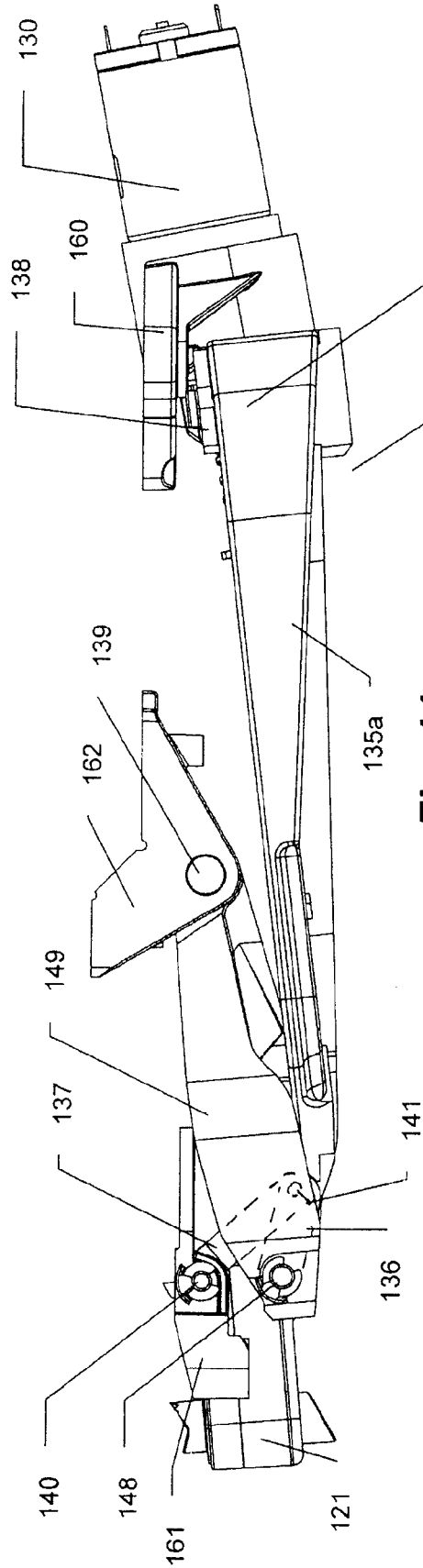


Fig. 11a

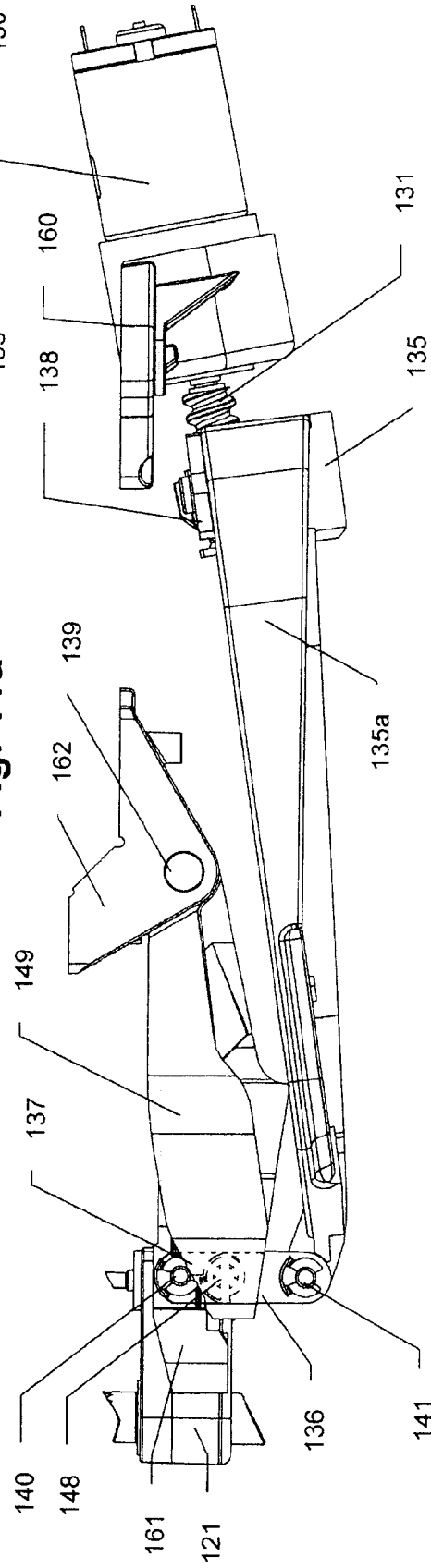


Fig. 11b

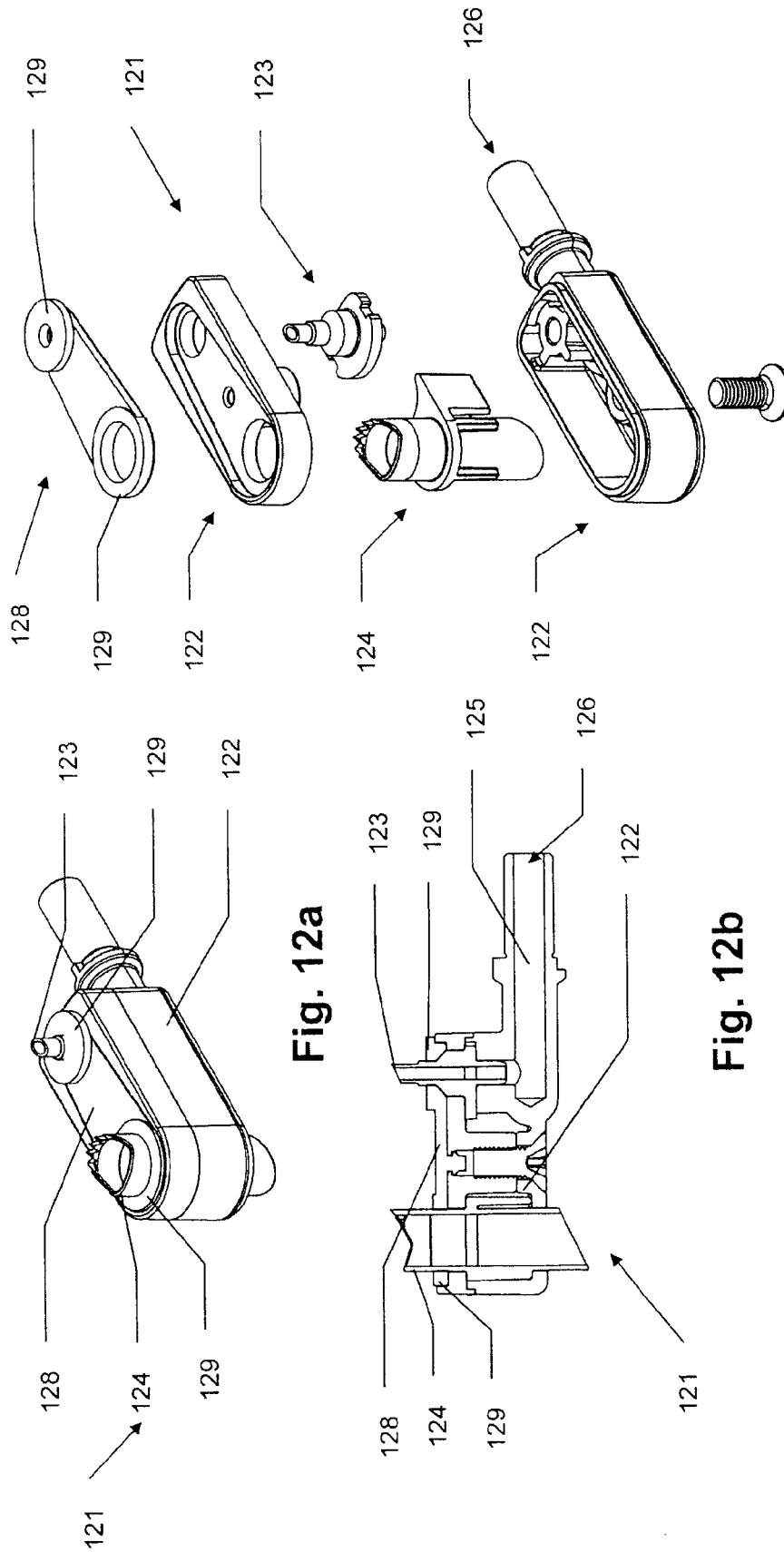


Fig. 12a

Fig. 12b

Fig. 12c

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IN OR RELATING TO BEVERAGE PREPARATION MACHINES

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a U.S. national phase application filed under 35 U.S.C. §371 of International Application PCT/US2008/063832, filed on May 16, 2008, designating the United States, which claims benefit to U.S. Application No. 60/940,118, filed on May 25, 2007, and Great Britain application GB 0709589.6, filed on May 18, 2007, all of which are hereby incorporated by reference herein.

FIELD

The present invention relates to improvements in beverage preparation machines and in particular to a delivery head for a beverage preparation machine of the type which use pre-packaged containers of beverage ingredients.

BACKGROUND

Beverage preparation machines such as coffee or tea brewing machines are well known. It is known to provide beverage preparation machines which dispense individual servings of beverage directly into a receptacle such as a cup. Such machines may derive the beverage from a bulk supply of beverage ingredients or from packages of beverage ingredients such as pods, pads or cartridges. An example of one type of such packages is shown in EP1440903. In the following specification such packages will be referenced by the general term cartridges. However, the invention is not limited to use with one particular type of pod, pad or cartridge. The beverages are formed from brewing, mixing, dissolving or suspending the beverage ingredients in water. For example, for coffee beverages, heated water is passed through the cartridges to form the extracted solution. The use of cartridges in such machines has become increasingly popular due to their convenience and the quality of the beverage produced.

In general, during use of such cartridges an inlet and an outlet are formed in the cartridge to allow for water entry and beverage discharge. Typically, the inlet and outlet are formed by piercing elements wherein either the cartridge or the piercing elements are moved in order to pierce the inlet and outlet. Beverage machines are known which use a carriage or platform which carries the cartridge and moves the cartridge relative to fixed piercing elements. It is also known to provide a vertically movable piercing element for piercing the inlet in a stationary cartridge. However, the piercing mechanisms of such machines tend to be bulky leading to the overall size of the machine being large.

SUMMARY

It is an object of the present invention to provide a delivery head and beverage preparation machine incorporating an improved piercing mechanism.

Accordingly, the present invention provides a delivery head for a beverage preparation machine comprising a movable first part and a fixed second part,

the first part being movable relative to the second part between an open position and a closed position,

in the open position the first part being positioned to enable loading of a cartridge into the delivery head,

in the closed position the first part and second part being positioned to hold said cartridge in a dispensing position,

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the delivery head further comprising an inlet piercer and an outlet piercer,

the inlet piercer and the outlet piercer being orientated substantially in the same direction and being pivotable relative to the fixed second part between a retracted position and a piercing position.

The use of pivoting inlet and outlet piercers allows for a more compact delivery head. In addition, piercing the inlet and the outlet in the same direction allows for a more compact unit since the cartridge only requires piercing in a single side or face.

Preferably the inlet piercer and the outlet piercer are orientated substantially vertically upwards in the piercing position.

Preferably the inlet piercer and the outlet piercer are orientated for piercing a lowermost face of said cartridge.

Preferably the retracted position of the inlet piercer and the outlet piercer is lower than the piercing position.

Preferably the retracted position of the inlet piercer and the outlet piercer is angled at between 5 and 10 degrees from the piercing position.

More preferably the retracted position of the inlet piercer and the outlet piercer is angled at greater than 7.5 degrees from the piercing position.

The fixed second part may comprise a horizontal support for said cartridge and the inlet piercer and the outlet piercer may extend vertically above the horizontal support in the piercing position.

Preferably the inlet piercer and the outlet piercer do not extend vertically above the horizontal support in the retracted position. Advantageously, this helps prevent user contact with the piercers when the first part is in an open position. In addition, retracting the piercers below the level of the support allows for easier removal of the cartridge after delivery.

Preferably the first part is pivotable between the open position and the closed position.

Preferably the delivery head further comprises a motor for pivoting the inlet piercer and the outlet piercer between the retracted and piercing positions. This allows for automation of the operation of the piercers by a controller of the machine.

Preferably the delivery head comprises a rear and a front wherein the motor is located to a rear of the delivery head and the inlet piercer and the outlet piercer are located to the front of the delivery head. In this way, the motor is located remote from the parts of the delivery head which are exposed to liquids during use. In particular the discharging beverage from the cartridge does not pass in the vicinity of the motor. This helps to keep the motor clean and operating correctly.

Preferably the motor is positioned at substantially the same height as the inlet piercer and the outlet piercer when in the raised position. Advantageously, the location of the motor at substantially the same height as the piercers rather than directly above or below the piercers allows for a more compact delivery head to be produced. In particular, the overall height of the delivery head can thus be minimised.

Preferably the motor is connected to the inlet piercer and the outlet piercer by a piercer mechanism.

Preferably the piercer mechanism is arranged to convert rotary motion of the motor into pivoting motion of the inlet piercer and the outlet piercer.

Preferably the delivery head further comprises an ejection passage into which said cartridge may be delivered wherein the ejection passage is located intermediate the inlet and outlet piercers and the motor. By positioning the motor on the opposite side of the ejection passage from the piercers, it is

unnecessary for the cartridges during ejection to pass over or near the motor. Again, this helps to maintain the cleanliness of the motor.

Preferably the piercer mechanism spans the ejection passage.

In particular, the piercer mechanism may define an aperture and the ejection passage passes through said aperture.

The ejection passage may comprise an ejection chute, the ejection chute comprising a chute housing, wherein the chute housing passes through said aperture.

The piercer mechanism may comprise a primary link, the primary link comprising a first end and a second end, wherein the first end of the primary link is coupled to the motor such that rotation of the motor causes longitudinal movement of the primary link.

The primary link may be elongate in a longitudinal axis and movable substantially along its longitudinal axis in response to rotation of the motor.

The piercer mechanism may further comprise a secondary link, the secondary link comprising a first end and a second end, wherein the first end of the secondary link is coupled to the second end of the primary link wherein movement of the primary link causes the secondary link to rotate relative to the fixed second part.

Preferably the secondary link comprises a pair of secondary link members.

The piercer mechanism may further comprise a tertiary link, the tertiary link comprising a first end and a second end, wherein the first end of the tertiary link is coupled to the first end of the secondary link wherein movement of the secondary link causes the tertiary link to rotate relative to the fixed second part.

Preferably the tertiary link comprises a pair of tertiary link members.

The first end of the tertiary link may also be coupled to the second end of the primary link.

The second end of the tertiary link may be coupled to the fixed second part.

The delivery head may further comprise a quaternary link, the quaternary link being rotatably coupled to the fixed second part, wherein the second end of the secondary link is rotatably coupled to the quaternary link.

Advantageously the secondary link and the tertiary link form a toggle clamp mechanism. Advantageously because of this the secondary and tertiary links snap into, and have a propensity to remain in, a position associated with the piercing mechanism being in a raised position until a positive retraction force is applied by the motor.

Preferably in the piercing position, the secondary link and the tertiary link are orientated substantially vertically. In this way, the secondary and tertiary links are best orientated to absorb and withstand vertical loads applied downwardly during use to the piercing mechanism when the first part is in the closed position and the piercing mechanism is raised.

The delivery head may further comprise a body comprising the inlet piercer and the outlet piercer, wherein the body is rotatably coupled to the fixed second part.

Preferably the piercing mechanism comprises an aperture through which an ejection passage passes.

Advantageously the use of a sliding and rotatable linkage for the piercing mechanism ensures consistent and reliable operation of the mechanism. In particular, considering that portions of the linkage may come into contact with liquids during use, rotating link members which transfer rotary motion of the motor into pivoting motion of the piercers is preferable to use of a cam and follower arrangement because

the cam surfaces of such arrangements can become soiled by dried-on deposits from the dispensed beverages.

In addition, the present linkage has the advantage that retraction or lowering of the piercers takes place under positive force—in other words the piercers are pulled down by the linkage—rather than relying on gravity or spring bias in order to return to their retracted position. This means the piercers are less likely to become stuck in the raised position.

The delivery head may further comprise a piercing unit wherein the piercing unit comprises the inlet piercer and the outlet piercer.

Preferably the piercing unit comprises a piercing body comprising a fluid inlet and a transfer conduit, the transfer conduit communicating between the fluid inlet and the inlet piercer.

Preferably the piercer body further comprises a unitary seal member which surrounds both the inlet piercer and the outlet piercer.

Preferably the piercing body, the inlet piercer and the outlet piercer are separate components which are assemblable to form the piercer unit.

The present invention also provides a beverage preparation machine comprising a delivery head as described above.

Further the present invention provides a beverage preparation system comprising the beverage preparation machine as described above and one or more cartridges, wherein the one or more cartridges contain one or more beverage ingredients.

The present invention also provides a method of use of a beverage preparation machine having a delivery head of the type having a movable first part, a fixed second part, an inlet piercer and an outlet piercer, the inlet piercer and the outlet piercer being orientated substantially in the same direction and being pivotable relative to the fixed second part between a retracted position and a piercing position, comprising the steps of:

- moving the first part into an open position;
- loading a cartridge into the delivery head;
- moving the first part into a closed position so as to clamp the cartridge in a dispensing position;
- rotating the inlet piercer and the outlet piercer into the piercing position to pierce said cartridge;
- dispensing a beverage from the cartridge;
- rotating the inlet piercer and the outlet piercer from the piercing position into the retracted position;
- moving the cartridge to an ejection position;
- ejecting the cartridge.

Preferably in the piercing position both the inlet piercer and the outlet piercer are orientated substantially vertically upwards.

Preferably the inlet piercer and the outlet piercer rotate by between 5 and 10 degrees between the retracted position and the piercing position.

More preferably the inlet piercer and the outlet piercer rotate by greater than 7.5 degrees between the retracted position and the piercing position.

Preferably the movement of the inlet piercer and the outlet piercer is motorised.

Preferably the first part pivots between the open position and the closed position.

Preferably the cartridge translates between the dispensing position and an ejection position.

BRIEF DESCRIPTION OF THE DRAWINGS

An embodiment of the present invention will now be described, by way of example only, with reference to the accompanying drawings in which:

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FIG. 1 is perspective view of a first version of beverage preparation machine according to the present invention which includes first and second delivery heads;

FIG. 2 is a perspective view of a second version of beverage preparation machine according to the present invention which includes a single delivery head;

FIG. 3 is a cross-sectioned perspective view of a delivery head according to the present invention in an open position;

FIG. 4 is a cross-sectioned perspective view of the delivery head of FIG. 3 in the open position and with a first cartridge inserted;

FIG. 5 is a cross-sectioned perspective view of the delivery head of FIG. 3 in a closed position with the cartridge in a dispensing position;

FIG. 6 is a cross-sectioned perspective view of the delivery head of FIG. 3 in the closed position with a piercing unit of the delivery head in a raised position;

FIG. 7 is a cross-sectioned perspective view of the delivery head of FIG. 3 in an ejection position;

FIGS. 8a and 8b are elevational views of the delivery head of FIG. 3 with some parts shown in section and some parts omitted for clarity illustrating movement of a cartridge guide of the delivery head;

FIGS. 9a to 9d are cross-sectional views of the delivery head of FIGS. 8a and 8b with some parts sectioned and with a second cartridge inserted, illustrating movement of the cartridge guide on closure of the delivery head;

FIG. 10 is a perspective view of a piercing mechanism of the delivery head of FIG. 3;

FIGS. 11a and 11b illustrate operation of the piercing mechanism of FIG. 10; and

FIGS. 12a to 12c illustrate a piercer unit of the delivery head of FIG. 3.

DETAILED DESCRIPTION

The beverage preparation machines 1 of FIGS. 1 and 2 each comprise a housing 2 containing the internal mechanisms of the machine such as a water reservoir, a pump, heating means and control means.

The machine 1 of FIG. 2 comprises a single brewer. The machine 1 of FIG. 1 comprises a first brewer and a second brewer coupled together.

Each brewer of the machines 1 comprises a delivery head 3 provided towards an upper part of the housing 2 in which, in use, is received a cartridge containing one or more beverage ingredients. The delivery head or heads 3 are connected with a chassis of the machine 1 on assembly. The delivery heads 3 are preferably identical. Beverage is dispensed from the brewer through an outlet spout 5 by pumping water from the reservoir of the brewer through the cartridge to form the beverage which is then directed through the outlet spout 5 into a cup 6. As can be seen in FIG. 1, two outlet spouts 5 are provided for a machine with two brewers.

As shown in FIG. 3, the delivery head 3 comprises a lower part 80, an upper mechanism 90 and a cartridge guide 110. Some parts of the outer cowl of the delivery head have been omitted for clarity. In practice the outer cowl will comprise a number of mouldings shaped to contain and protect the internal components of the delivery head.

The lower part 80 comprises a housing 81 formed from upper and lower mouldings. The housing 81 defines a motor cavity 88 towards a rear of the delivery head 3, a piercer unit cavity 86 towards a front of the delivery head 3 and a barcode reader cavity 87 at a foremost portion of the delivery head 3. A forward part of the upper surface of the housing 81 is provided with a flattened support surface 82 in which is

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located a piercer unit aperture 83 and a barcode window 84. Rearward of the support surface 82 the upper moulding is shaped to define an ejection chute 85 that is open to below the delivery head 3.

The upper mechanism 90 comprises a carriage frame 95, a handle 92, a clamping mechanism 93, a lead screw 96, and a motor 97.

The carriage frame 95 forms the core of the upper mechanism and provides a structural framework for the other components of the upper mechanism. The carriage frame 95 comprises an elongate frame extending from a front end 155 to a rear end 154 as shown in FIG. 3. The frame comprises two side members 151 and an upper member 152 joining the two side members 151. The upper member 152 is provided with two upstanding webs 156 as most clearly shown in FIG. 9b. Each side member 151 comprises an elongate side slot 106 and the upper member 152 comprises an elongate upper slot 153 as most clearly shown in FIG. 5. The carriage frame 95 is preferably formed from a single moulding and is symmetric about a midline of the delivery head 3.

The carriage frame 95 is pivoted to the lower part 80 by a pair of hinges 98 formed on the upstanding webs 156 at pivot points 150 as most clearly seen in FIGS. 9b to 9d. The hinges 98 are offset from the upper surface of the lower part 80 and positioned above the level of the support surface 82. As most clearly shown in FIG. 9a by omission of certain parts of the housing 91, the hinges 98 may comprise a cog 157 having teeth 158 which engage with a damping member during pivoting of the carriage frame 95 to thereby provide control over the pivoting speed of the carriage frame 95. For example, the damping member may act to ensure that if the handle 92 of the delivery head 3 is released when the carriage frame 95 is in the raised position then the carriage frame 95 pivots downwardly in a controlled manner rather than free-falling into contact with the lower part 80. The damping member may comprise a cog suitable for engaging the cog 157 and a damper, such as a rotatable vane, movable within a viscous damping fluid such as oil.

The handle 92 is connected to the carriage frame 95 and extends around a front of the delivery head 3. The handle 92 is pivotably connected to the carriage frame 95 by a mechanism such that with the carriage frame 95 in a lowered position the handle 92 can be depressed to engage hooks provided on the handle 92 with bosses provided on the lower part 80 in order to securely hold the carriage frame in the lowered position. An example of such a mechanism is described in EP1440644. However, such a mechanism is not relevant to the present invention. The clamping mechanism 93 comprises a cup-shaped clamp member 100 and a cup-shaped socket 94. The clamp member 100 is provided with a central spigot 101. A plurality of flexible protrusions 102 are provided on an exterior of the clamp member 101 which engage with an inwardly-directed flange 103 of the socket 94 so as to retain the clamp member 100 fixedly within the socket 94 on assembly. The socket 94 is provided on an upper surface with a cylindrical member 104 in which is seated a threaded nut 105. The threaded nut 105 is engaged on the lead screw 96. The socket 94 of the clamping mechanism 93 is also provided with a pair of bosses or similar which are engaged in, and slidable along the side slots 106 of the carriage frame 95 so as to maintain correct orientation of the socket 94 on operation of the lead screw 96. Consequently, rotation of the lead screw 96 can be used to move the socket 94, and hence the clamp member 100 reciprocally along the longitudinal axis of the upper mechanism 90 from the front end 155 to the rear end 154 of the carriage frame 95 as will be described below when the operation of the delivery head 3 is discussed. As best

shown in FIGS. *8a* and *8b* the socket **94** further comprises a pair of tail pieces **108** which extend rearwardly from either side of the cup-shaped body of the socket **94**. The tail pieces **108** are each provided with a pin **107** at or near a distal end thereof, the use of which will be described below.

The lead screw **96** is mounted to the carriage frame **95**. The lead screw **96** is located towards a top of the carriage frame **95** in the opening provided by the upper slot **153** as shown in FIG. *5*. Thus, the lead screw **96** extends above the socket **94** and extends along the longitudinal axis of the upper mechanism **90** from the rear end **154** to the front end **155** of the carriage frame **95**. The motor **97** is operatively connected to a rear end of the lead screw **96** and is able to rotate the lead screw **96** both clockwise and counter-clockwise. As shown, the motor **97** is mounted to the carriage frame **95** and transverse the longitudinal axis of the upper mechanism **90** to save space and is connected to the lead screw **96** by means of a suitable gear arrangement such as bevel gears.

The cartridge guide **110** is located inbetween the lower part **80** and the upper mechanism **90**. The cartridge guide **110** rests on and is slidable relative to the lower part **80** whilst being operatively interconnected with the upper mechanism **90** as described below.

The cartridge guide **110** comprises an annular member **111** and two vertically extending webs **113**. The annular member **111** and webs **113** are formed as a single moulding from, for example, a plastics material. The annular member **111** comprises a ring defining an aperture **112** shaped to receive a cartridge **70**. The lower face of the cartridge guide **110** rests on the support surface **82**. Whilst the aperture **112** closely conforms to the shape of the cartridge **70** in order to enable precise orientation and placement of the cartridge, it is slightly larger than the cartridge **70** such that a cartridge **70** placed within the aperture **112** rests on the support surface **82** of the lower part **80** rather than on the cartridge guide **110** itself. The aperture **112** is shaped also to accommodate a handle portion **71** of the cartridge **70** as shown in FIG. *4*. The handle **71** is thereby orientated to a front of the delivery head **3** and positioned symmetrically on the midline of the delivery head **3**.

The webs **113** are located on each side of the cartridge guide **110** and, as best shown in FIGS. *8a* and *8b*, are each provided with a slot **114** of arcuate form in which, on assembly, the pins **107** of the socket **94** are slidably received. Thus, the cartridge guide **110** and the clamping mechanism are interconnected. Each slot **114** comprises a first portion **115** in the shape of an arc having a centre of rotation coincident with the pivot point **150** of the clamping mechanism **93**. Each slot **114** also comprises a second portion **116** in the shape of an arc whose instantaneous centre of curvature is not co-incident with the pivot point **150**. The function of the slot **114** will be described below.

The delivery head **3** further comprises a barcode reader **120** and a piercing mechanism **119**.

The barcode reader **120** is located in the barcode reader cavity **87** and is orientated to be able to transmit and receive signals through the barcode window **84**.

The piercing mechanism **119** comprises a piercer unit **121**, a motor **130**, a lead screw **131** and a linkage mechanism **133**. The piercing mechanism **119** is operative to raise and lower the piercer unit **121**. The piercer unit **121** is located in the piercer unit cavity **86** of the lower part **80**.

As shown in FIGS. *12a* to *12c* the piercer unit **121** comprises a body **122** having mounted therein an inlet piercer **123** and an outlet piercer **124**. The body **122** is provided with a conduit **125** linking the inlet piercer **123** with a fluid inlet **126** of the body **122**. The fluid inlet **126** is coupled by pipework to

a supply of water on assembly of the delivery head with the remainder of the machine **1**. A seal member **128** is located on an upper face of the body **122** surrounding the inlet piercer **123** and the outlet piercer **124**. The seal member **128** is provided with raised annular portions **129** surrounding the piercing element of the inlet piercer **123** and the piercing element of the outlet piercer **124**.

The piercer unit cavity **86** is also provided with a spout chute **89** as shown in FIG. *3* into which the piercer unit **121** extends. The spout chute **89** acts as a funnel to channel beverage discharged through the outlet piercer **124** to the outlet spout **5** located at a bottom of the spout chute **89**.

The motor **130** is located at a rear of the delivery head remote from the piercer unit **121**. The motor **130** is orientated generally in line with a longitudinal axis of the lower part **80** but is angled downwardly slightly below the horizontal. The motor **130** is coupled to the lead screw **131** by means of a threaded, generally U-shaped, rear coupling member **138** as most clearly seen in FIG. *10*. A distal end of the lead screw **131** is provided with an end stop. The motor **130** is able to rotate the lead screw **131** both clockwise and counter-clockwise in order to move the rear coupling member **138** reciprocally forwards and backwards relative to the lower part **80**.

As shown in FIG. *10*, the linkage mechanism **133** comprises a U-shaped primary link **135** having a pair of forward-extending arms **135a**, a pair of secondary links **136**, a pair of tertiary links **137**, the rear coupling member **138** and a forward coupling member **149**. The linkage mechanism is mounted to the lower part **80** by means of a rear mounting plate **160**, a front mounting plate **161** and two side mounting plates **162** which are all securely mounted to an underside of the upper moulding of the lower part **80**.

A pair of first pivot points **139** are provided by the side mounting plates **162**. A pair of second pivot points **140** are provided by the front mounting plate **161**.

As most clearly shown in FIGS. *10*, *11a* and *11b*, the U-shaped primary link **135** is rotatably coupled at a rear end to the rear coupling member **138**.

The forward coupling member **149** comprises a generally U-shaped member having two arms **146** and an interconnecting bridge **147**. The distal ends of the arms **146** are rotatably coupled to the first pivot points **139**.

The secondary links **136** are rotatably connected to the primary link arms **135a** at third pivot points **141** such that a forward end of each primary link arm **135a** is connected to a rear end of the respective secondary link **136**. The opposite end of each secondary link **136** is rotatably coupled to the forward coupling member **149** at fourth pivot points **148**.

The tertiary links **137** are connected between the third pivot points **141** (where the primary link arms **135a** and secondary links **136** are coupled) and the second pivot points **140** on the front mounting plate **161**.

The piercing unit **121** is rigidly mounted to the interconnecting bridge **147** of forward coupling member **149** as shown in FIG. *10*. Alternatively the piercer unit **121** could be formed as one piece with the front coupling member **149**.

As most clearly shown in FIG. *10*, the linkage mechanism **133** transfers motive force from the motor **130** at the rear of the delivery head **3** to a front of the delivery head **3**. In addition, by using pairs of primary link arms **135a**, secondary links **136** and tertiary links **137** as well as U-shaped members **135**, **149** the linkage mechanism extends around the ejection chute **85** without impeding the chute as shown in FIG. *5*.

Operation of the piercing mechanism **119** will be described below.

The beverage preparation machine also comprises a controller for controlling operation of the machine including

operation of components of each delivery head **3** such as the motors **95**, **130**, and the barcode reader **120**.

The delivery head **3** may also be provided with interlock or sensing devices linked to the controller to provide data to the controller on the position of the socket **94** on its lead screw **96**, the position of the piercing mechanism **119** and the position of the upper mechanism **90**, for example whether the upper mechanism **90** is in the closed position. Typically an interlock is provided to confirm closure of the handle **92** when the upper mechanism **90** is in the lowered position. Operation of the delivery head **3** is prevented when this interlock indicates that the handle **92** is opened.

As an alternative to providing an interlock on the lead screw **96** to indicate the position of the socket **94** current sensing control may be used. In current sensing the current drawn by the motor **97** is monitored and the controller interprets an increase in the drawn current above a pre-set threshold to be indicative of the socket **94** having reached one of its end stops at either the front end **155** or rear end **154** of the carriage frame **95**.

In use, the delivery head **3** is first opened to allow insertion of a cartridge **70** of the type having a bowl-shaped upper portion **76** sealed by a flexible lower membrane **77** around a peripheral flange **78** by moving the upper mechanism **90** into the raised position as shown in FIG. 3. Opening of the upper mechanism is achieved by first opening the handle **92** to disengage the hooks from the bosses of the lower part **80** and then lifting the handle **92**. As shown in FIG. 3 and in FIG. 9a, in the raised position of the upper mechanism **90**, the cartridge guide **110** is positioned in a forward-most position to ease loading of the cartridge **70** and the clamping member **100** is raised as part of the upper mechanism **90**. The cartridge guide **110** is thus positioned because of the interaction of the pins **107** of the tail pieces **108** in the slots **114** of the cartridge guide **110**. In particular in the raised position each pin **107** is moved to a top of the first portion **115** of the slot **114** as shown in FIG. 9a.

The cartridge **70** is then inserted into the aperture **112** of the cartridge guide **110** such that the cartridge **70** rests on the support surface **82** as shown in FIG. 4. In FIG. 4 the delivery head **3** is shown with a cartridge **70** having a relatively shallow profile. The handle portion **71** of the cartridge **70** is aligned towards a front of the delivery head **3** and lies on the midline of the delivery head **3**.

The upper mechanism **90** is then closed into the position shown in FIG. 5 by pressing down on the handle **92**. Closure of the upper mechanism **90** causes the cartridge guide **110** and the cartridge **70** to slide rearwardly over the support surface **82** into a dispensing position wherein the cartridge **70** is correctly aligned with the piercer aperture **83** and the barcode window **84**. The rearward movement of the cartridge guide **110** is caused by the interaction of the pins **107** and slots **114**. As shown in FIG. 8a, 8b and FIGS. 9a to 9d downward rotation of the upper mechanism **90** causes the clamping mechanism **93** also to rotate downwardly moving the pins **107** first along the first portion **115** of the slots **114** and then along the second portion **116**. Movement of the pins **107** along the first portion **115** of the slots to the position shown in FIG. 9c does not cause any movement of the cartridge guide **110** since the centre of curvature of the first portion **115** is coincident with the point of rotation of the clamping mechanism **93**. However, further downward rotation of the clamping mechanism **93** does cause rearward sliding of the cartridge guide **110** due to the pins **107** bearing against a rearmost face of the slots **114** to thereby force the cartridge guide **110** to move to accommodate the pin's movement into the position shown in

FIG. 9d. In the closed position of the clamping mechanism **93** the cartridge guide **110** has moved in a rearward direction by between 7.8 and 10 mm.

In the closed position the spigot **101** of the clamping member **100** is engaged in a relatively shallow central well **75** formed in the upper portion **76** of the cartridge **70**. The clamping member **100** is also provided with a formation **79** aligned with an inlet region of the cartridge **100**. The lower rim of the clamping member **100** is aligned with and is designed to make contact with the peripheral flange **78** of the cartridge **70** in the closed position. Thus, in the closed or clamped, position the clamping member **100** applies a clamping force on the cartridge **70**. This force is mainly applied to the central region of the cartridge **70** by the spigot **101** and to the inlet region of the cartridge **70** by the formation **79**. However, if required the lower rim of the clamping member **100** may apply a relatively small force to the peripheral flange **78**. At this point the piercer unit **121** is still lowered. Therefore the force applied to the cartridge **70** urges the cartridge into contact with the support surface **82**. Thus, the lower membrane **77** carries some of the applied load in the area immediately surrounding the piercer aperture **83**. In addition, the remainder of the load applied to the cartridge **70** is carried through the peripheral flange **78** where it contacts the support surface **82**.

Closure of the upper mechanism **90** also triggers operation of the barcode reader **120** to read the barcode on the cartridge **70** by transmitting through the barcode window **84**. The received detected signal is then fed to the controller which thereby determines the correct dispense parameters for the inserted cartridge, such as water temperature, volume, steeping time, etc.

Opening of the upper mechanism **90** after a dispense cycle and ejection have taken place results in a reversal of the movement of the cartridge guide **110** described above.

A particular advantage of this movement of the cartridge guide **110** is to allow accommodation of cartridges having a relatively deep profile, such as the type of cartridge **70** shown in FIGS. 9a to 9d. As shown in FIGS. 9a to 9d maintaining the cartridge guide **110** in the loading position of FIG. 9a until the clamping mechanism **93** has rotated partially down to the point shown in FIG. 9c allows the lower rim of the clamping member **100** to clear the upper rear point **73** of the cartridge **70**. The subsequent rearward movement of the cartridge **70** allows for a clamping member **100** that closely conforms to the diameter of the cartridge to be used whilst avoiding fouling of the clamping member's rim on a front face **74** of the cartridge or of the spigot **101** on the sides of the relatively deep central well **75** of the cartridge **70**. In this way the size of the clamping member **100** is minimised without requiring a substantially vertical movement of the clamping mechanism **93** to be used to allow insertion of cartridges of varying depth.

As shown in FIG. 5, at this point the piercer unit **121** is in the lowered position such that the inlet piercer **123** and outlet piercer **124** are fully below the level of the support surface **82**. On receipt of a start command from the user (by for example, pressing a start/stop button), the controller of the machine **1** operates the motor **130** to raise the piercing mechanism **119** into the raised position shown in FIG. 6 such that the inlet piercer **123** and outlet piercer **124** are raised proud of the level of the support surface **82**. In the raised position the piercer unit **121** is raised to the point where the seal member **128** is orientated substantially horizontally with the general level of the seal member **128** being level with the support surface **82**. However, in this position the raised annular portions **129** of the seal member **128** lie slightly above the level of the support surface **82**. In this way the raised annular portions **129** are able to distort slightly and thereby tension the flexible lower mem-

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brane 77 of the cartridge 70. The peripheral flange 78 of the cartridge 70 remains in contact with the support surface 82 due to the constraining contact of the lower rim of the clamping member 100.

In addition, the upward movement of the piercer unit 121 urges the cartridge 70 more tightly against the spigot 101 and the formation 79 of the clamping member 100 to increase the clamping force which holds the cartridge 70 in position between the clamping member 100 and the piercer unit 121. Thus, the combination of the action of the clamping member 100 and the piercer unit 121 creates a minimum clamping force of 30N at the inlet of the cartridge and a force of between 75 and 130N at the outlet.

The movement of the piercing mechanism 119 from lowered to raised position is most clearly seen in FIGS. 11a and 11b and involves a rotation of the piercer unit 121 about its pivot point of between 5 and 10 degrees and preferably greater than 7.5 degrees. On operation of the motor 130, the rear coupling member 138 is moved forwards by approximately 20 mm by rotation of the lead screw 131. As a result of the coupling of the rear coupling member 138 with the primary link 135 the primary link 135 is moved substantially in a direction in line with the longitudinal axis of the primary link although this may be accompanied by a slight rotational movement of the primary link 135 relative to the rear coupling member 138. At the same time the primary link arms 135a push on the lower ends of the secondary links 136. Due to the constraint of the tertiary links 137, which couple the primary link arms 135a and the secondary links 136 to the second pivot points 140, the pushing movement of the primary link arms 135a causes the secondary links 136 to rotate in a clockwise sense as viewed in FIG. 11b. This rotation results in upward rotation of the front coupling member 149 due to the coupling of the secondary links 136 to the front coupling member 149 and the coupling of the arms 148 of the front coupling member 149 to the first pivot points 139 of the side mounting plates 162. Upward rotation of the front coupling member 149 consequently results in upward rotation of the piercer unit 121 due to the rigid connection of the piercer unit 121 to the front coupling member 149. In the raised position, the tertiary links 137 are substantially vertical and also aligned with the secondary links 136 which are also vertically aligned. In this position the secondary and tertiary links are best able to resist the downward loads applied by the clamping member 100 to the cartridge 70. The movement of the secondary and tertiary links also acts in the manner of a toggle clamp wherein the secondary and tertiary links snap into, and have a propensity to remain in, the position of FIG. 11b until a positive retraction force is applied by the motor 130.

Raising of the piercing mechanism 119 causes piercing of the cartridge 70 by the inlet piercer 123 and the outlet piercer 124 to form respectively an inlet and an outlet in the underside of the cartridge 70.

Once the controller detects that the piercer unit 121 is in the raised position dispensation of a beverage from the cartridge 70 begins. As with operation of the lead screw current sensing of the motor 130 may be used by the controller to determine the position of the piercer unit 121. Heated water is channelled from the fluid inlet 126 through the conduit 125 and inlet piercer 123 and into the cartridge. The resultant beverage is discharged through the outlet piercer 124, spout chute 89 and out of outlet 5 into a waiting receptacle 6.

Once dispensation has stopped the piercer unit 121 is lowered by reversing the operation described above by operating the motor 130 in a reverse direction. This clears the inlet

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piercer 123 and the outlet piercer 124 out of the ejection path of the cartridge 70 and also removes a portion of the loading applied to the cartridge 70.

The controller then operates motor 97 to eject the cartridge 70 by movement of the cartridge 70 to an ejection position. Operation of the motor 97 rotates the lead screw 96 causing the clamping socket 94 and clamping member 100 to slide rearwards into the position shown in FIG. 7. The clamping member 100 moves the cartridge 70 along with it thereby dragging the cartridge 70 over the ejection chute 85. During this movement the cartridge 70 is still under some loading from the socket 94 of the upper mechanism 90. Once the cartridge 70 is substantially or wholly aligned with the chute 85 it falls under gravity down the chute 85 into a waste bin in a lower part of the machine 1. It is to be noted that during this movement the outer part of the housing 91 of the upper mechanism 90 remains stationary such that the motion of the clamping mechanism 93 remains internal to the delivery head 3. A particular advantage is that the delivery head 3 does not need to be opened in order to eject the cartridge 70. In addition, the clamping mechanism 93 affects not only clamping of the cartridge 70 during dispensation of beverage but also ejection of the cartridge 70.

The motor 97 is then reversed to move the clamping mechanism 93 back into the forward position ready for the next dispensing cycle.

Optionally a steam purge may be used to clean the piercer unit cavity 86, support surface 82, and clamping member 100. Steam is directed through the inlet piercer 123. The steam purge may be carried out with the piercer body 121 in the raised or lowered position. In addition, it may be carried out automatically after each dispensation cycle and or carried out from time to time under either manual user control or automatic control of the controller. A steam purge may also be used during the dispensation cycle when the cartridge 70 is in the dispensation position to dry out the cartridge 70 and to help drive out any remaining liquid in the cartridge 70.

The invention claimed is:

1. A delivery head for a beverage preparation machine comprising a movable first part and a fixed second part, the first part being movable relative to the second part between an open position and a closed position, in the open position the first part being positioned to enable loading of a cartridge into the delivery head, in the closed position the first part and second part being positioned to hold said cartridge in a dispensing position, the delivery head further comprising a piercer body and an inlet piercer and an outlet piercer mounted to the piercer body, the inlet piercer and the outlet piercer being orientated in the same direction on the piercer body and the piercer body having the inlet and outlet piercers thereon is pivotally attached to the fixed second part so as to pivot the inlet and outlet piercers between a retracted position and a piercing position relative to the fixed second part.
2. The delivery head of claim 1 wherein the inlet piercer and the outlet piercer are orientated vertically upwards in the piercing position.
3. The delivery head of claim 1 wherein the retracted position of the inlet piercer and the outlet piercer is lower than the piercing position.
4. The delivery head of claim 1 wherein the retracted position of the inlet piercer and the outlet piercer is angled at between 5 and 10 degrees from the piercing position.

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5. The delivery head of claim 1 wherein the retracted position of the inlet piercer and the outlet piercer is angled at greater than 7.5 degrees from the piercing position.

6. The delivery head of claim 1 wherein the fixed second part comprises a horizontal support for said cartridge and the inlet piercer and the outlet piercer extend vertically above the horizontal support in the piercing position, but do not extend vertically above the horizontal support in the retracted position.

7. The delivery head of claim 1 wherein a piercer mechanism is arranged to convert rotary motion of a motor of the piercer mechanism into pivoting motion of the piercer body and the inlet piercer and the outlet piercer thereon.

8. The delivery head of claim 7 further comprising an ejection passage configured to receive said cartridge wherein the ejection passage is located intermediate the inlet and outlet piercers and the motor.

9. The delivery head of claim 7 wherein the piercer mechanism comprises a primary link, the primary link comprising a first end and a second end, wherein the first end of the primary link is coupled to the motor such that rotation of the motor causes longitudinal movement of the primary link.

10. The delivery head of claim 9 wherein the piercer mechanism further comprises a secondary link, the secondary link comprising a first end and a second end, wherein the first end of the secondary link is coupled to the second end of the primary link wherein movement of the primary link causes the secondary link to rotate relative to the fixed second part.

11. The delivery head of claim 10 wherein the piercer mechanism further comprises a tertiary link, the tertiary link comprising a first end and a second end, wherein the first end of the tertiary link is coupled to the first end of the secondary link wherein movement of the secondary link causes the tertiary link to rotate relative to the fixed second part.

12. The delivery head of claim 9 wherein the piercing mechanism comprises an aperture through which an ejection passage passes.

13. The delivery head of claim 10 further comprising a quaternary link, the quaternary link being rotatably coupled to the fixed second part, wherein the second end of the secondary link is rotatably coupled to the quaternary link.

14. The delivery head of claim 1 wherein the piercer body includes a fluid inlet and a transfer conduit communicating between the fluid inlet and the inlet piercer.

15. A delivery head for a beverage preparation machine comprising a movable first part and a fixed second part,

the first part being movable relative to the second part between an open position and a closed position,

in the open position the first part being positioned to enable loading of a cartridge into the delivery head,

in the closed position the first part and second part being positioned to hold said cartridge in a dispensing position,

the delivery head further comprising an inlet piercer and an outlet piercer,

the inlet piercer and the outlet piercer being orientated in the same direction and the inlet and outlet piercers being pivotally attached to the fixed second part so as to pivot between a retracted position and a piercing position relative to the fixed second part, and

a linkage mechanism connected to the inlet and outlet piercers and mounted to the fixed second part with the linkage mechanism being configured to pivot the inlet and outlet piercers between the retracted position and the piercing position relative to the fixed second part.

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16. The delivery head of claim 15 wherein the inlet piercer and the outlet piercer are orientated vertically upwards in the piercing position.

17. The delivery head of claim 15 wherein the retracted position of the inlet piercer and the outlet piercer is lower than the piercing position.

18. The delivery head of claim 15 wherein the retracted position of the inlet piercer and the outlet piercer is angled at between 5 and 10 degrees from the piercing position.

19. The delivery head of claim 15 wherein the retracted position of the inlet piercer and the outlet piercer is angled at greater than 7.5 degrees from the piercing position.

20. The delivery head of claim 15 wherein the fixed second part comprises a horizontal support for said cartridge and the inlet piercer and the outlet piercer extend vertically above the horizontal support in the piercing position, but do not extend vertically above the horizontal support in the retracted position.

21. The delivery head of claim 15 wherein further comprising a motor and the linkage mechanism is arranged to convert rotary motion of the motor into pivoting motion of the inlet piercer and the outlet piercer.

22. The delivery head of claim 21 further comprising an ejection passage configured to receive said cartridge wherein the ejection passage is located intermediate the inlet and outlet piercers and the motor.

23. The delivery head of claim 21 wherein the linkage mechanism comprises a primary link, the primary link comprising a first end and a second end, wherein the first end of the primary link is coupled to the motor such that rotation of the motor causes longitudinal movement of the primary link.

24. The delivery head of claim 23 wherein the linkage mechanism further comprises a secondary link, the secondary link comprising a first end and a second end, wherein the first end of the secondary link is coupled to the second end of the primary link wherein movement of the primary link causes the secondary link to rotate relative to the fixed second part.

25. The delivery head of claim 24 wherein the linkage mechanism further comprises a tertiary link, the tertiary link comprising a first end and a second end, wherein the first end of the tertiary link is coupled to the first end of the secondary link wherein movement of the secondary link causes the tertiary link to rotate relative to the fixed second part.

26. The delivery head of claim 25 further comprising a quaternary link, the quaternary link being rotatably coupled to the fixed second part, wherein the second end of the secondary link is rotatably coupled to the quaternary link.

27. The delivery head of claim 15 further comprising an ejection passage configured to receive said cartridge and the linkage mechanism comprises an aperture through which the ejection passage extends.

28. The delivery head of claim 15 further comprising a piercing body having the inlet and outlet piercers mounted thereon and being pivotally mounted to the fixed second part, the piercing body being connected to the linkage mechanism for being pivoted relative to the second part and moving the inlet and outlet piercers between the retracted and piercing positions.

29. The delivery head of claim 15 wherein the linkage mechanism includes a toggle clamp having a locked configuration that maintains the inlet and outlet piercers in the piercing position thereof and an unlocked configuration that permits the inlet and outlet piercers to pivot to the retracted position thereof.

30. The delivery head of claim 29 wherein the toggle clamp includes pivotally connected links and the links have a first

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orientation with the toggle clamp in the locked configuration and a different, second orientation with the toggle clamp in the unlocked configuration.

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